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THE RHODODENDRON WHITEFLY AND ITS CONTROL

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INTRODUCTION

The rhododendron whitefly (*Dialeurodes chittendeni* Laing) has only recently been discovered in this country, and the very limited published information concerning it relates to conditions outside of the United States. This circular is intended to give nurserymen and gardeners the results of studies of the pest that have been conducted in the Pacific Northwest. While the experimental data used as a basis for this discussion are not complete by any means, they are sufficient to provide a better understanding of the status of the rhododendron whitefly in the United States and to suggest effective remedial measures that can be utilized for its control.

HISTORY AND DISTRIBUTION

The rhododendron whitefly was described as a new species of the genus *Dialeurodes* in 1928 by Laing of the British Museum,[2] from pupal cases and adults taken from rhododendrons at Ascot, England, and this is apparently the first published record of its occurrence, although it had previously been found at Chiddingfold, Surrey, England, in 1926. Since then it has become prevalent in parts of England and has caused noticeable injury to cultivated rhododendrons there.

[1] Acknowledgments are due to C. F. Doucette, under whose supervision this work was planned and carried out; to the following members of the Bureau of Entomology and Plant Quarantine: E. R. Sasscer for records of distribution, and A. G. Webb and W. H. Wheeler, of the plant quarantine inspection office at Seattle, Wash., for assistance in observations and furnishing survey records; and to numerous estate owners and gardeners near Seattle and Tacoma, Wash., for their cooperation in control studies.

[2] Laing, F. Description of a new white fly pest of rhododendrons. Ent. Monthly Mag. 64: 228–230, illus. 1928.

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In 1932 it was intercepted on rhododendrons imported from England for use in the plant-introduction gardens of the Bureau of Plant Industry. As a result of the effects of treatments to rid them of the infestation, these plants died.

In the spring of 1933 the whitefly was found at Seattle, Wash., on rhododendrons that had been imported from England a few weeks before. This infestation was localized on two plants, which were later fumigated, and the insect was apparently exterminated. Further survey of the Puget Sound section, actuated by this chance discovery, however, revealed the presence of the rhododendron whitefly in well-established infestations near Seattle and Tacoma, Wash., in the Fraser River Valley east of Vancouver, British Columbia, and on Vancouver Island near Victoria. With one exception, it was found only on private estates and in each case had apparently been established for several years. No infestations have been discovered in commercial nurseries in the State of Washington.

In 1934 infested plants, which had been imported from England originally, were found in a commercial nursery on Long Island, N. Y.

In 1935 larvae of this whitefly were intercepted by the California State inspection service on rhododendrons shipped from Tennessee. A survey of the area of their origin revealed the presence of this whitefly quite generally on native rhododendrons (*Rhododendron maximum*) growing in the wild near Johnson City, Tenn. Although many infested leaves were found, the degree of infestation in each case was extremely light. Native rhododendrons from eastern Tennessee planted at Washington, D. C., were also found to be lightly infested.

In 1936 plants shipped from White Sulphur Springs, W. Va., and from Stroudsburg and Germantown, Pa., were found to be infested with the insect when inspected at Washington, D. C.

Entomologists in England[3] have suggested that this species is of Himalayan origin and was transported to England on plants from that area. It seems quite probable that the infestations in the Puget Sound section and on Long Island are a continuation of those reported from England. No definite evidence is available regarding the origin of the infestations on native rhododendrons in the eastern part of the United States. The presence of the insect in this region, however, would show that it is more widely distributed in this country than was first indicated. Further surveys are likely to reveal infestations in other sections.

CHARACTER OF INJURY

The larvae and pupae of the rhododendron whitefly are located on the under sides of the terminal leaves (pl. 4, *A*). When excessive numbers are present their feeding causes a yellow mottling to appear on the upper surface of the leaves attacked, and in some varieties this is accompanied by a curling of the leaf margins. Although a large population of whitefly larvae may be present, the rate of development is so slow that the feeding is not deleterious

[3] WILSON, G. F. THE RHODODENDRON WHITE FLY. Jour. Roy. Hort. Soc. 60: 264–271, illus. 1935.

to leaf growth or appearance until spring. With the rapid development of the third-instar larvae, the consumption of plant sap is sufficient to cause the mottled appearance. Considerable loss in ornamental value is also due to the formation of sooty mold fungus on the lower leaves, which catch the honeydew dropped by the whitefly larvae above them (pl. 1). As rhododendrons retain their leaves for approximately 3 years, a plant rapidly loses its ornamental value after whitefly infestation has persisted for more than one season.

ECONOMIC IMPORTANCE

In actual damage to plants, the rhododendron whitefly has as yet been responsible for very little loss in the United States. Until its host relationships are better understood, however, it has potentialities that cause its presence to be viewed with considerable concern, for, in spite of having only one generation a year, this whitefly is capable of rapidly building up a damaging population within a few seasons, once it is established on a plant. Plants examined 2 years in succession were found to have only a few larvae (10 to 20) per leaf the first year, in comparison with several hundred (250 to 500) per leaf the second season.

Rhododendrons have great value as evergreen ornamentals, and they are extensively used on both the Atlantic and Pacific slopes. Native plants grow in considerable areas in certain States and are considered of much ornamental value in their wild state. In the areas suitable for rhododendron growth, nurseries propagate hybrids for resale all over the country. Therefore, until a complete list of the immune or partially immune species and hybrid varieties is known, and especially until the effect of the insect on native wild plantings is positively determined, this pest will occupy the attention of those persons interested in rhododendron culture.

HOST PLANTS

So far as has been observed both in the United States and in England, the only hosts upon which this whitefly goes through its life cycle are evergreen rhododendrons, and, of these, only those species and varieties whose leaves permit the development of the life cycle of the insect. The presence of scales or tomentum on the under surfaces of the leaves apparently prevents the establishment of the insect thereon, and leaves with thick or leathery epidermis are partially or wholly resistant to attack. Instances discussed in succeeding paragraphs demonstrate these varying degrees of mechanical immunity.

Studies on the susceptibility of hybrid varieties have been hindered by the fact that all known infestations of the rhododendron whitefly in the Puget Sound section occur in estate plantings, where the identity of many of the varieties has been lost. In the following list of species and varieties some of the common rhododendrons occurring in western Washington are given, and the degree of infestation found on them is indicated. The infestation recorded does not necessarily represent the degree of resistance to the whitefly.

LIST OF THE SPECIES AND HYBRID VARIETIES OF RHODODENDRONS FOUND INFESTED IN WASHINGTON STATE

Species	*Degree of infestation found*
R. californicum	Light.
R. metternichi	Do.
Varieties	
Abraham Lincoln	Medium heavy.
Album Elegans	Medium.
Avalanche	Do.
Boule de Neige	Light.
Caractacus	Medium light.
Catawbiense Album	Heavy.
Charles Bagley	Light.
Charles Dickens	Medium light.
Christmas Cheer	Light.
Cunningham White	Medium.
Cynthia	Do.
Delicatissimum	Light.
Double Fastuosum	Do.
Dr. H. C. Dresselhuys	Medium.
Enchantress	Very light.
Everest	Light.
F. L. Ames (Amphion)	Do.
General Grant	Heavy.
Goldsworth Yellow	Light.
Gomer Waterer	Very light.
Ignatius Sargent	Light.
Juno (Roseum Superbum)	Medium heavy.
Kettledrum	Heavy.
Mrs. Charles Sargent	Light.
Parsons Gloriosa	Medium heavy.
Pink Pearl	Light.
Roseum Elegans	Medium heavy.

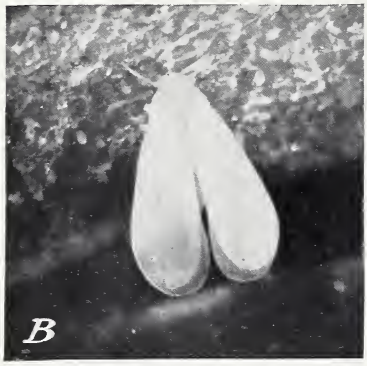
Pink Pearl, which is an important commercial variety and extensively grown on the west coast, appears to be only partially favored as a host. In many instances where this variety has been segregated in ornamental plantings no whiteflies were found on it, although only a few feet of lawn or driveway separated it from a general infestation on other varieties. Some whiteflies were found on over 100 Pink Pearl on a large estate where a medium to heavy infestation prevailed on other varieties adjacent to it, but no leaves were more than lightly infested.

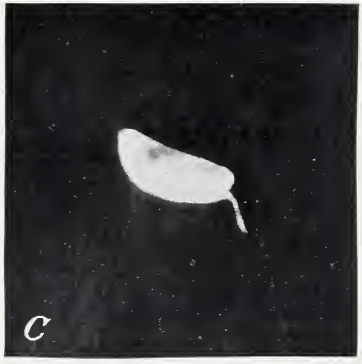
The varieties Christmas Cheer and Gomer Waterer were also only lightly infested when growing adjacent to varieties with considerable infestation.

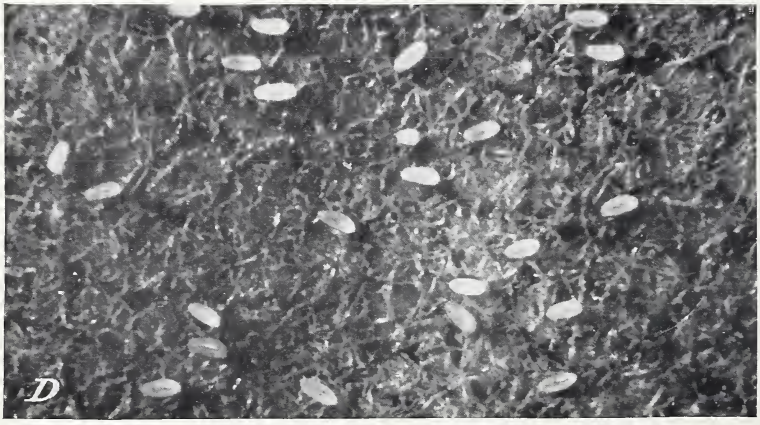
The light infestations recorded from native rhododendrons in both Washington (*R. californicum*) and Tennessee (*R. maximum*) would indicate that these two species are less favored hosts. No infestation has been found on wild plants of *R. californicum* in Washington State, but transplanted ones in proximity to infested hybrid varieties are usually infested to some degree. On many plants under observation for 3 years the whitefly population did not build up, but remained quite light from year to year; in a few instances, however, a fairly heavy population has been found on groups of this native species. In Tennessee, inspectors found only one or two larvae per leaf on *R. maximum* growing in natural environment. The occurrence of this whitefly on wild plants would presuppose a long-estab-

RHODODENDRON LEAVES DISCOLORED BY SOOTY MOLD FUNGUS

A, Leaf with a heavy deposit of sooty mold. *B*, Young terminal leaves spotted with sooty mold.



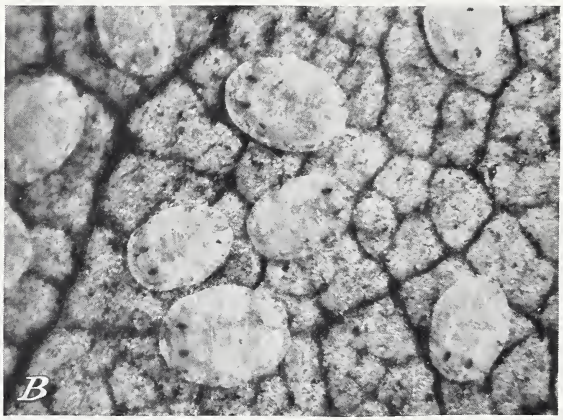




ADULTS AND EGGS OF THE RHODODENDRON WHITEFLY.

A, Adults in resting position (× 17). *B*, Adult on the midrib of a leaf (× 17). *C*, Egg (× 68). *D*, Eggs on the under side of a leaf (× 24).

ADULTS OF THE RHODODENDRON WHITEFLY ON RHODODENDRON LEAVES.
A, Adults congregating on new leaves just unfurling (× ¾). *B*, Adults on newly opened leaves (× ¾).



LARVAE AND PUPAE OF THE RHODODENDRON WHITEFLY ON RHODODENDRON LEAVES.

A, Pupae on the under side of a leaf (× 1½). *B*, Nearly mature pupae (× 14). *C*, Second-instar larvae (smallest form), third-instar larvae (intermediate size), and newly molted pupae (largest form) (× 14).

lished infestation rather than one of recent origin. If this is true, there is little likelihood of serious damage to this species of rhododendron, since it has been observed that on preferred hosts the increase in population has been rather rapid when calculated over a period of several years. Even though *R. maximum* proves to be an unfavored host, eradication measures would be impractical in nurseries near infested areas, because the native plants would serve as a constant source of reinfestation.

DESCRIPTION OF STAGES

The adult whiteflies have yellow bodies and two pairs of unspotted white wings (pl. 2, *A*, *B*). As usually seen on plants, the white wings mask the body coloring and the insects appear to be entirely white. The average length of the body is 1.4 mm, and the average wing spread is 2.7 mm.

The eggs are small, about one-fourth millimeter in length, and slightly greenish (pl. 2, *C*, *D*). A small stalk attaches the egg to the rhododendron leaf. The eggs are laid indiscriminately on the under surfaces of new leaves just unfurling from their buds (pl. 3, *B*). Leaves still quite tightly rolled were found to contain many adults and eggs between the surfaces (pl. 3, *A*). On two small leaves 595 and 629 eggs were counted.

The three larval stages and the pupae are oval, flattened, scalelike in appearance, and are greenish yellow (pl. 4). The first-instar larvae are motile for a short period and actively crawl about on the leaf upon which they hatched. They soon settle, and after they have inserted their stylets into the leaf tissues they remain stationary. This stage is easily recognized under a hand lens by a marginal row of long hairs (fig. 1). The legs and antennae are complete, and the shape of the body is more elongate than in the later stages. The average length is 0.335 mm.

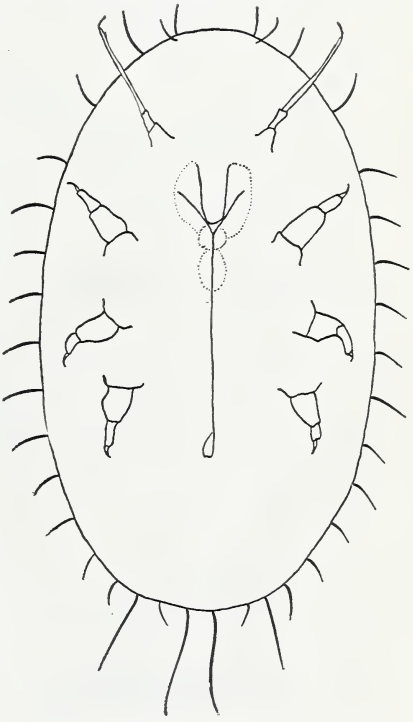


FIGURE 1.—Ventral view of first-instar larva (or crawler) of the rhododendron whitefly (× 225).

The second-instar larvae (pl. 4, *C*) are about one-third longer than those of the first instar. They have lost most of their legs and have much shortened antennae. The marginal hairs are visible only as very abbreviated spines, and the general shape is less elongate. The average length is 0.434 mm.

The third-instar larvae (pl. 4, *C*) present almost the same appearance but are a half longer than those of the second instar. The average length is 0.674 mm.

The pupa (pl. 4 and fig. 2) is twice as long as the third-instar larva, and at first is very flat, but as the transformation to an imago takes place it becomes more and more convex. The adult whitefly emerges by splitting the skin on the upper surface near the anterior end. The old pupal cases remain on the leaves for one or two seasons and are useful for the detection of an infestation when the active stages are too small to be seen without a lens. The average length is 1.33 mm.

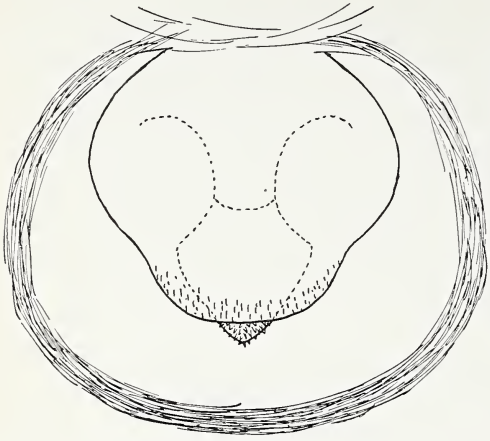


FIGURE 2.—Vasiform orifice of the pupa of the rhododendron whitefly (approximately × 1,000). This is one of the principal structural characters used in the identification of the species.

SEASONAL HISTORY

In Washington State there is only one generation of the rhododendron whitefly a year. First-instar larvae have been found as late as February 28 and pupae as early as November 30, which might be construed by a casual observer as indicating two or more genera-

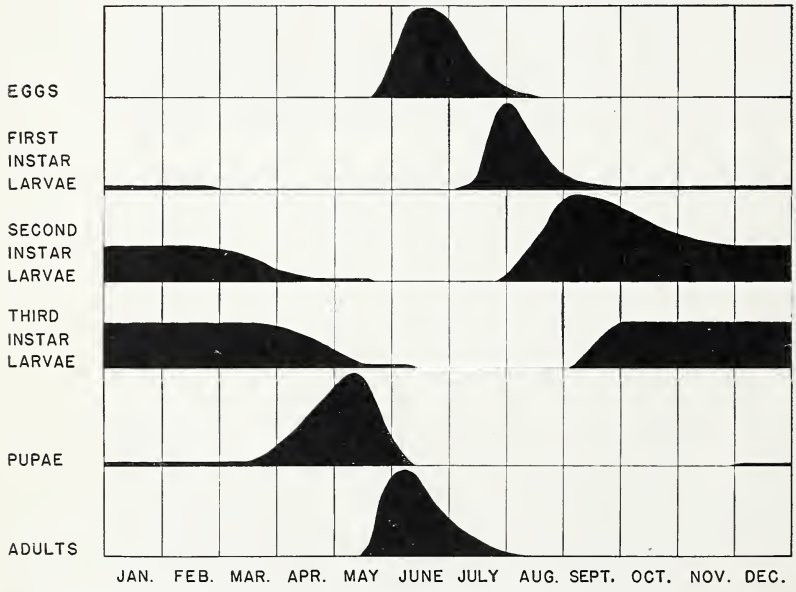


FIGURE 3.—Seasonal history of the rhododendron whitefly at Seattle, Wash.

tions a year. Observations made weekly throughout an entire year definitely proved that only a single generation occurred and indicated the relation of these stragglers to the developmental trend of

the whole population. Figure 3 shows the interlapping of stages which explains the simultaneous occurrence of such forms.

The female oviposits on the under surfaces of the new leaves as they are breaking out of bud. The young crawlers move about on the leaves until they settle and insert their stylets to feed upon plant sap, after which they become sedentary. The second-instar larvae begin to appear late in July or early in August and many of them persist until late in the spring. Larvae of the third instar begin to appear in September and increase as those of the second instar decrease during the early fall. Development is very slow in the winter, during which time the second- and third-instar larvae are present in approximately the same number. A few pupae may appear as early as November, but it is not until April and May that the peak development of this stage occurs. Adults start emerging late in May and have been found through July.

NATURAL SPREAD

Brief studies on the rate of natural dissemination indicate that the rhododendron whitefly is slow in spreading. Adults were observed to concentrate on certain plants, usually those with a heavy infestation the previous year, and to return to the same plants when disturbed. Known preferred host plants, originally heavily infested but almost completely freed of whitefly larvae by sprays applied in control experiments, were examined after the oviposition period and very few eggs were found. These plants were from 15 to 75 feet away from plants still heavily infested, but even these short distances acted as a strong hindrance to reinfestation. On the other hand, this apparent concentration of adults upon their original host plant tends to build up a population very rapidly even though this insect reproduces only once annually. Populations of larvae were observed to increase from less than 50 per leaf to between 250 and 500 per leaf the following generation.

CONTROL

For field control, light oils, specially prepared for spraying purposes, have been found to be very effective against the larvae and pupae of the whitefly and to be well tolerated by the host plants. Sprays containing 2 percent of such oils are sufficient for control in areas where the whitefly is generally present. In isolated infestations or in nurseries where complete control is desirable, the strength of the oil spray should be increased to 4 percent.

The adult whiteflies are quite susceptible to nicotine, which will effectively reduce the population during the time they are flying. Nicotine dusts have been tried in England [4] and were effective in tests there. Nicotine sprays, made up by diluting 1 part of nicotine sulphate (40-percent nicotine) with 800 parts of water, with soap added at the rate of 1 ounce per gallon, have been successfully used against adults at Seattle, Wash.

Tests with a spray of nicotine sulphate (prepared as described above) and with a spray of an aliphatic thiocyanate proved that such sprays were not effective against the larval and pupal stages of the whitefly.

[4] WILSON, G. F. See footnote 3.

Oil sprays for the control of whitefly larvae may be applied at almost any season of the year, but early in the fall before frosts occur is probably the best period. At that time the whitefly larvae have not developed to the point where their feeding is detrimental to the plant, and, furthermore, the terminal leaves are still erect and the mechanical difficulties of spraying are lessened.

With the advent of low temperatures, rhododendron leaves generally droop close to the stems, making it very difficult at times to reach the under leaf surfaces with a spray. The mechanical difficulties of covering all the under surfaces are considerable at any season. The spray is best applied with a power sprayer that will produce a fine spray with great velocity. The nozzle should be directed upward, and special attention should be given to applying the spray to the terminal clusters of leaves. In permanent ornamental plantings it is often quite difficult to spray infested plants adequately, especially where they have attained a spread and height of over 10 feet or are planted in a border in front of dense evergreen growth.

If oil sprays are applied during the summer months, a lighter or summer grade of oil should be used. In the fall or spring heavier oils or light dormant-season oils would probably be satisfactory. In experimental tests a dormant-season oil with a viscosity of 100 to 110 seconds Saybolt and an unsulphonated residue of 74 to 76 percent was successfully used in western Washington during the winter months.

Many proprietary oil emulsions are for sale, and any standard brand of these would probably be satisfactory. In some cases it might be advisable for the grower to buy the straight oil and either prepare his own emulsion or emulsify the oil at the time of application by the so-called tank-mix method.

Since it is known that severe burning often follows applications of oil sprays on certain evergreens in the presence of hot sunshine, it would perhaps be advisable to spray on cloudy days. In experimental work on rhododendrons, plants were sprayed on bright days with no resulting injury, but the tests were not numerous enough to determine whether this tolerance could always be expected.

SUMMARY

The rhododendron whitefly, recently discovered in the United States, seriously impairs the ornamental value of susceptible species and varieties of rhododendrons. Varieties vary in their susceptibility to attack because of physical differences in the structure of their leaf surfaces. In western Washington there is only one generation a year, which corresponds with conditions reported in England. The overwintering forms are principally the second- and third-instar larvae. The natural spread from plant to plant is slow because the adults apparently prefer to remain on the plant on which they developed. Oil sprays can be successfully used for the immature stages, a 2-percent spray giving satisfactory control, but twice that strength is desirable if eradication is attempted. Nicotine, either as a spray or dust, can be used to reduce adult populations.

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